The PMM

USNO

NOFS

The Precision Measuring Machine

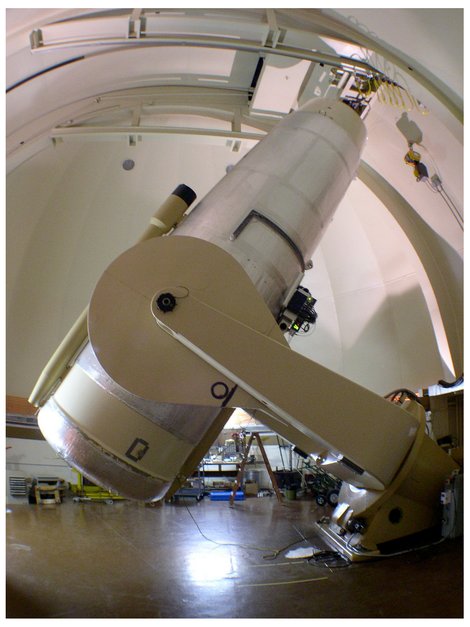
The Precision Measuring Machine (PMM) is a very large and specialized image scanner. One of the principle aims of the Precision Measuring Machine project has been to digitize photographic images of the whole sky taken over a 50 year time span. These data are then used to create deep dense catalogues of all the natural objects in the sky. We are also left with a 13Terabyte digital library of images covering the sky from roughly 1950 to the year 2000.

1 - Taking data at the telescope

Data were taken with Schmidt Telescopes using large format photographic plates (up to 14 x 14 inches square).

In the 1950s a major effort was made to image the whole northern sky photographically using the Oschin Schmidt telescope at Mount Palomar Observatory. This widely used plate collection is known as the First Palomar Observatory Sky Survey (or POSS-I), and was made possible with financial assistance from the National Geographic Society. A similar effort was made to map the southern sky during the 1970s and 1980s at the European Southern Observatory (ESO) and the Anglo-Australian Observatory (AAO). The all sky effort was repeated between 1985 and 2002, resulting in the POSS-II survey in the north and the corresponding southern surveys.

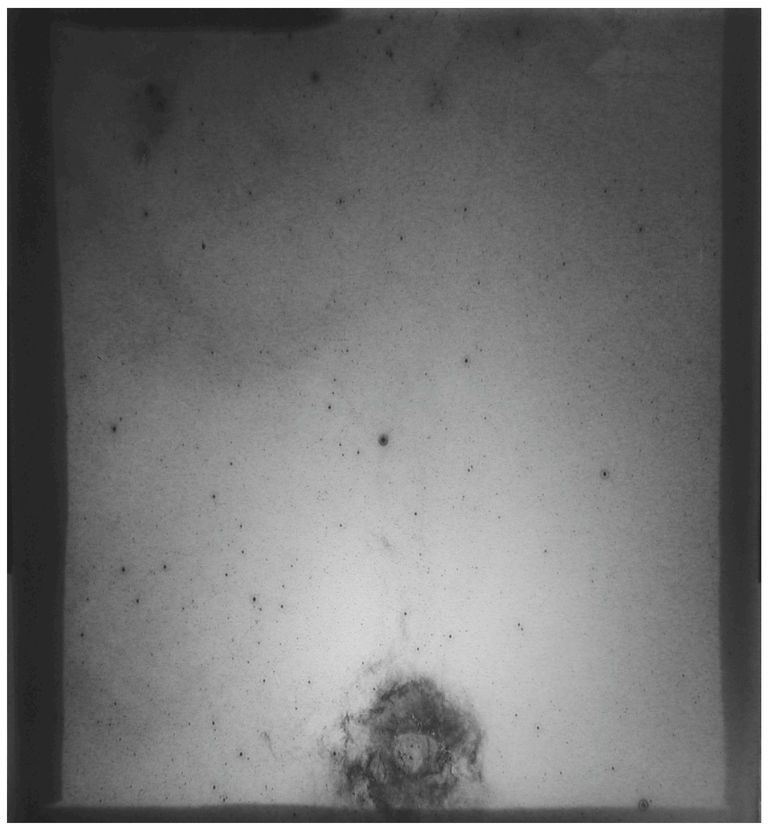
A recent picture of the Oschin Schmidt on Mount Palomar (image from Caltech at: *http://www.astro.caltech.edu/palomar/images/oschin_telescope_1.jpg)*



2 - The original data

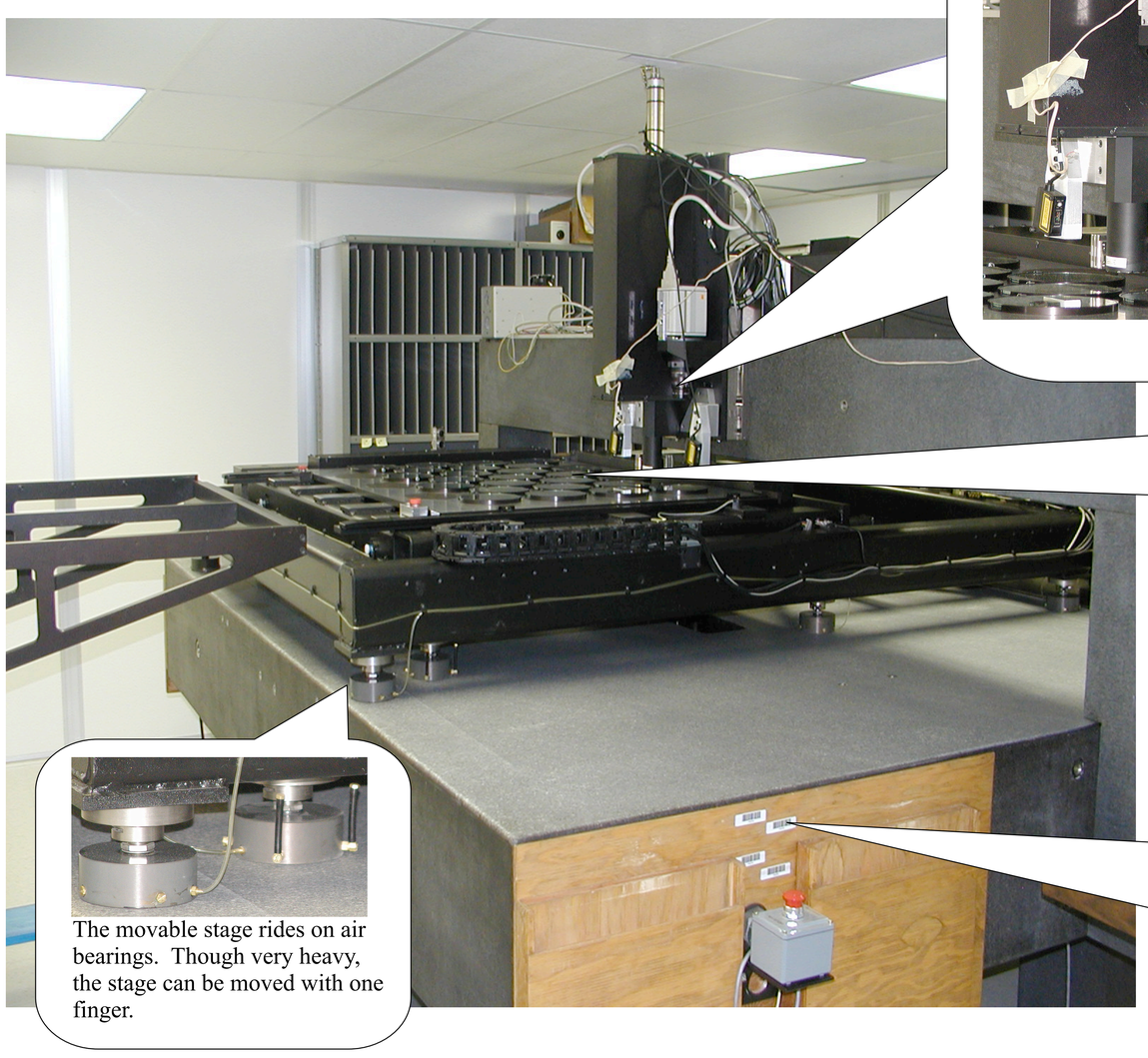
Here is a a slightly atypical 14x14 inch photograph from one of the Schmidt telescopes.

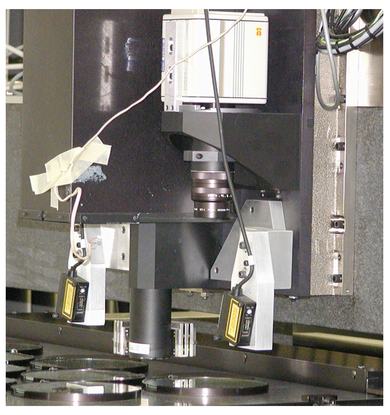
The image shown here is of a plate taken on the Oschin Schmidt telescope at Mount Palomar. It shows the Rosette (bottom center) and Cone (upper left corner) nebulae.



3 - Digitizing the photographs

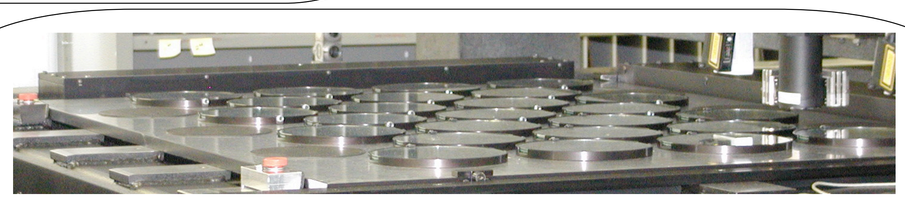
Using the Precision Measuring Machine, almost 20,000 large format glass photographs have been scanned.





The PMM uses two CCD cameras to digitize the photographic plates of the sky. For a 14x14 inch plate, 588 images are needed to cover the whole Schmidt plate.

To minimize the effects the local environment has upon scans of photographic plates, the PMM is housed in a temperature controlled clean room. The scanning assembly is built upon a large slab of granite, which provides both structural and thermal stability. In this machine, the cameras are fixed to the granite bridge that extends over the scan table. The platen holding the photographs is then moved back and forth in a raster pattern on the large scan platform. This platform is made up of two moving stages; each moves only in one direction, and the two directions are perpendicular to each other. The position of each stage is determined using a laser interferometer, and tells us the location of each stage to within 10 nanometers.



PMM platens are 30 x 40 inches and can hold up to four 14x14inch photographs, or 25 6inch diameter photographs at one time.

Each plate was given a bar code to help avoid typos when setting up a plate for scanning. By reading the bar codes at run time, the machine was told which plate was in which platen slot.

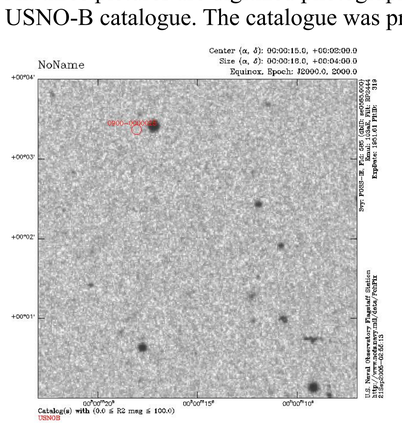
The movable stage rides on air bearings. Though very heavy, the stage can be moved with one finger.

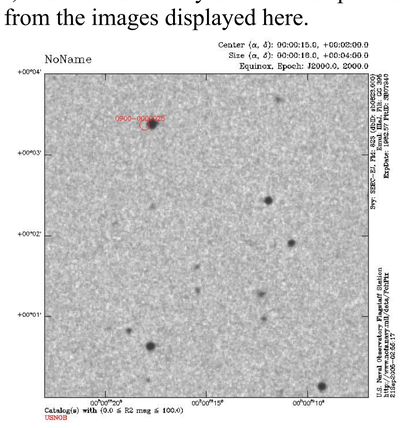
4 - Images, Detections and Catalogues

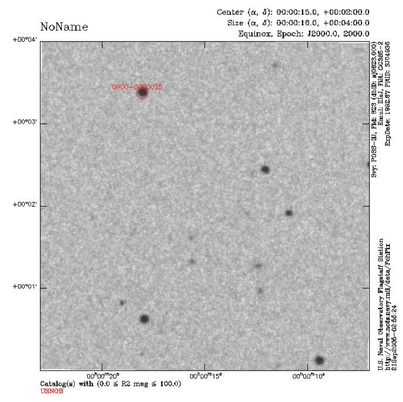
As the PMM scans each plate, it takes a sequence of images. These images are processed in real-time; the computer attempts to locate all the astronomical objects in the image and determine their position within the image. After all the plates have been scanned, the information in the lists of detections is combined to produce a final catalogue (such as the USNO-B catalogue) giving the position, motion and brightness of all the objects on the photographic plates.

A star of moderate motion, as seen in 1951, 1982 and 1991 (left to right).

All three pictures are digitized photographic plates, and the red overlay is the star's epoch 2000.0 position from the USNO-B catalogue. The catalogue was produced from the images displayed here.







5 - Data retrieval

The data from the scanned photographic plates are available over the web to anyone at

http://www.nofs.navy.mil/data/fchpix